

Carcass performance of Simmental and Holstein Friesian beef cattle in Serbia

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Abstract: The aim of this study was to determine the slaughter weight, hot carcass weight, cold carcass weight, dressing percentage, chilling loss, forequarter weight, hindquarter weight and participation of forequarters and hindquarters of the beef cattle breeds Simmental (males, females and cattle from repurchase) and Holstein Friesian. A total of 100 animals were studied. After slaughter, carcass parameters were measured individually. The results show that the Holstein Friesian cattle had a significantly lower ($p < 0.01$) average slaughter weight, hot carcass weight, cold carcass weight and dressing percentage than Simmental beef cattle. Also, females had a significantly lower average cold carcass weight than males ($p < 0.05$). Male Simmental beef cattle had significantly higher ($p < 0.01$) average forequarter and hindquarter weights than female Simmental beef cattle and Holstein Friesian cattle.

Keywords: Carcass performance, cattle, Simmental beef, Holstein Friesian beef.

Introduction

Improving carcass performance and meat quality traits are the main objectives of most research carried out in the beef production area. Meat quality is an important criterion that influences consumers' decisions to purchase beef (Baltic and Boskovic, 2015; Djordjevic, 2016). Beef meat contains about 23% protein, 2.8% fat, 73% water and 1.2% mineral matter. The energy value of beef meat is 494 KJ (116 kcal) per 100 g (Williams, 2007). Numerous factors, such as race, gender, age, diet and mode of production affect variations in the chemical composition of beef.

Meat production in Serbia is largely based on Simmental beef cattle, a dual purpose worldwide breed common in central Europe, slaughtered between 16–18 months and 600–700 kg live weight (Sami et al., 2004; Dokmanovic et al., 2014). Beef production in Serbia has decreased as result of permanent reductions in cattle numbers in the past twenty-five years (Dokmanovic et al., 2014). In the European Union, a deficit of beef will amount to 600,000 tons (Petricevic et al., 2015). According to data from the FAO (Food and Agriculture Organization of the United Nations), the average annual world beef consumption for 2010 was 9.4 kilograms per capita. The

highest beef consumption per capita for 2010 was in Argentina (55.7 kg) followed by Brazil with 39.8 kg and the US, with 38.2 kg. In EU countries, annual consumption of beef meat for the year 2010 was 16.4 kg per capita. (Anon., 2012).

Many studies (Mandell, et al., 1998; May et al., 1992; Sinclair et al., 1998; Maltin et al., 2001; Moloney et al., 2001) have shown the relationships among different production factors (age, breed, gender, feeding plan, etc.) and carcass characteristics of beef cattle. The breed and feeding plan is considered as one of the most important factors that affects meat production.

The objective of this study was to evaluate the carcass performance of Simmental and Holstein Friesian beef cattle in Serbia.

Materials and Methods

Experimental grouping of cattle

Simmental beef cattle (n=90) and Holstein Friesian beef cattle (n=10), all approximately 16 months old, were classified by gender and breed into four groups (Table 1). Group I (males), group II (females) and group III (repurchased from different

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Table 1. Experimental grouping of studied cattle

Simmental cattle		Holstein Friesian cattle	
Group I	Group II	Group III	Group IV
Males	Females	Repurchase	Males
n=50	n=30	n=10	n=10

origins) were Simmental beef cattle, while group IV comprised Holstein Friesian beef cattle.

Carcass analysis

Male cattle were fasted 18h before slaughter. Final live weights were recorded. Cattle were slaughtered at one of four commercial facilities. After slaughter, the hot and cold weights of the carcasses were measured. Carcasses were cooled for 24h at 4°C. Dressing proportions were calculated as the ratio of cold carcass weight to final live weight. Chilling loss was calculated as the ratio of hot carcass weight to cold carcass weight. The carcasses were divided between the 12th and 13th rib interface into forequarters and hindquarters (*Baltic*, 1994).

Statistical analysis

Statistical analysis of the results was conducted using GraphPad Prism version 6.00 for Windows (GraphPad Software, San Diego, CA, USA, www.graphpad.com). Each parameter was described by mean and standard deviation (SD). One-way ANOVA with Tukey’s test was performed to assess the significance of differences among various groups. Values of p<0.05 and p<0.01 were considered significant.

Results and Discussion

Table 2 shows the carcass performance of the four cattle groups. Average group slaughter weight was between 461.3±48.68 kg (group IV) and

586.9±75.40 kg (group I). The breed (p<0.01) and gender (p<0.05) significantly affected the slaughter weight, as higher weights were recorded for group I (male Simmental beef cattle) than group II (female Simmental beef cattle) and group IV (Holstein Friesian beef cattle). The effect of breed was more pronounced than the effect of gender. Group IV cattle, the Holstein Friesians, were significantly lighter at slaughter (p<0.01) than the other three groups, but differences between the Simmental cattle in groups I, II and III were less significant. The average hot carcass weight was between 250.7±28.80 kg (group IV) and 333.2±53.44 kg (group I). Group IV, the Holstein Friesians, had significantly lower hot carcass weights than Simmentals (groups I, II and III; p<0.01). The hot carcass weight of Simmental male cattle was significantly lower than the hot carcass weight of Simmental female cattle (p<0.05). Similar results were seen with cold carcass weight (Table 2).

The present study was conducted to evaluate the carcass performance in Simmental and Holstein Friesian beef cattle in Serbia. Our results (slaughter weight, hot carcass weight and cold carcass weight) were in accordance with those reported by other authors for Simmental beef cattle (*Piasentier et al.*, 2009; *Zapletal et al.*, 2009).

According to statistical data in Serbia, the average weight of adult animals before slaughter during 1995 to 2000 was 478 kg and from 2006 to 2011 was 504 kg. Lower masses compared to our results could be due to the fact that in those data, cattle were not separated by age and sex (*Dokmanovic et*

Table 2. Beef carcass performances (X±SD) of beef cattle groups

Weight (kg)	Group			
	I (n=50)	II (n=30)	III (n=10)	IV (n=10)
Slaughter	586.9 ^{A,a} ±75.40	541.5 ^{B,a} ±55.76	568.6 ^C ±41.67	461.3 ^{A,B,C} ±48.68
Hot carcass	333.2 ^{A,a} ±53.44	305.6 ^{B,a} ±31.82	313.4 ^C ±25.74	250.7 ^{A,B,C} ±28.80
Cold carcass	325.6 ^{A,a} ±53.17	296.5 ^{B,a} ±31.28	305.0 ^C ±25.25	245.3 ^{A,B,C} ±28.35

Legend: Within a row and each parameter, values were compared; Means with a common superscript letter differ: A, B, C; p<0.01; a, b; p<0.05.

al., 2014). The weights of male yearlings (Domestic Simmental), slaughtered in a Cajetina slaughterhouse ranged from 499 kg to 604 kg, while females of the same breed ranged from 430 kg to 481 kg (*Drca*, 2009). *Janjic* (2004) found that the average weight of yearlings slaughtered in Vraccvsnica ranged between 543 kg for male and 509 kg for female animals. In a Toplica slaughterhouse, the average weight of yearlings was 533 kg for male and 421 kg for female animals (*Dokmanovic et al.*, 2014). According to *Drca* (2009) the average carcass weight for male beef cattle ranged from 286 kg to 327 kg and for female from 230 kg to 266 kg. Male Simmental cattle (Germany) fed with a concentrate mixture had an average weight of 623 kg before slaughter, while those fed predominantly with roughage weighed around 620 kg (*Nuernberg et al.*, 2005). Holsteins fed with a concentrate mixture had an average weight of 619 kg before slaughter and those animals fed predominantly roughage weighed around 624 kg. Simmental animals were 495 days old and Holsteins were 394 days old (*Nuernberg et al.*, 2005). Before slaughter, Belgian Blue cattle weighed 755 kg (males) and 740 kg (females), while the cooled carcass weights were 501 kg and 470 kg, respectively (*Fiems et al.*, 2003).

According to *Kamienieckog et al.* (2009), Charolais bulls, Charolais x Hereford crossbreeds, and Charolais x Simmental crossbreeds had before

slaughter weights of 554 kg, 560 kg and 592 kg, respectively. Animals were 518, 547 and 518 days old, respectively.

Crossbreeding is widely used in the beef industry to increase a production. Many studies reported that carcass weight was higher in crossbreds compared to purebred beef cattle (*Kamieniecki et al.*, 2009). Positive heterosis for carcass weight has been found (*Neumann*, 2002; *Kamieniecki et al.*, 2009).

Figure 1 shows the average dressing percentage of the four cattle groups studied. The dressing percentage was between 54.22% (group IV) and 56.56% (group I). Dressing percentage was affected by cattle breed. Significant differences were found between groups IV (Holstein Friesian) and I (Simmental males) ($p < 0.01$), and between groups IV (Holstein Friesian) and II (Simmental females) ($p < 0.05$).

The average dressing percentage of Holstein Friesian cattle was significantly lower than Simmental cattle in the current study. Our dressing percentages accorded with those of *Waritthitham et al.* (2010) and *Sanudoa et al.* (2004). In research by *Chambaz et al.* (2003), Simmental beef cattle carcasses presented worse carcass conformation than Charolais and Limousin cattle, which were significantly heavier. *Fiems et al.* (2003) measured different dressing percentages in males and females.

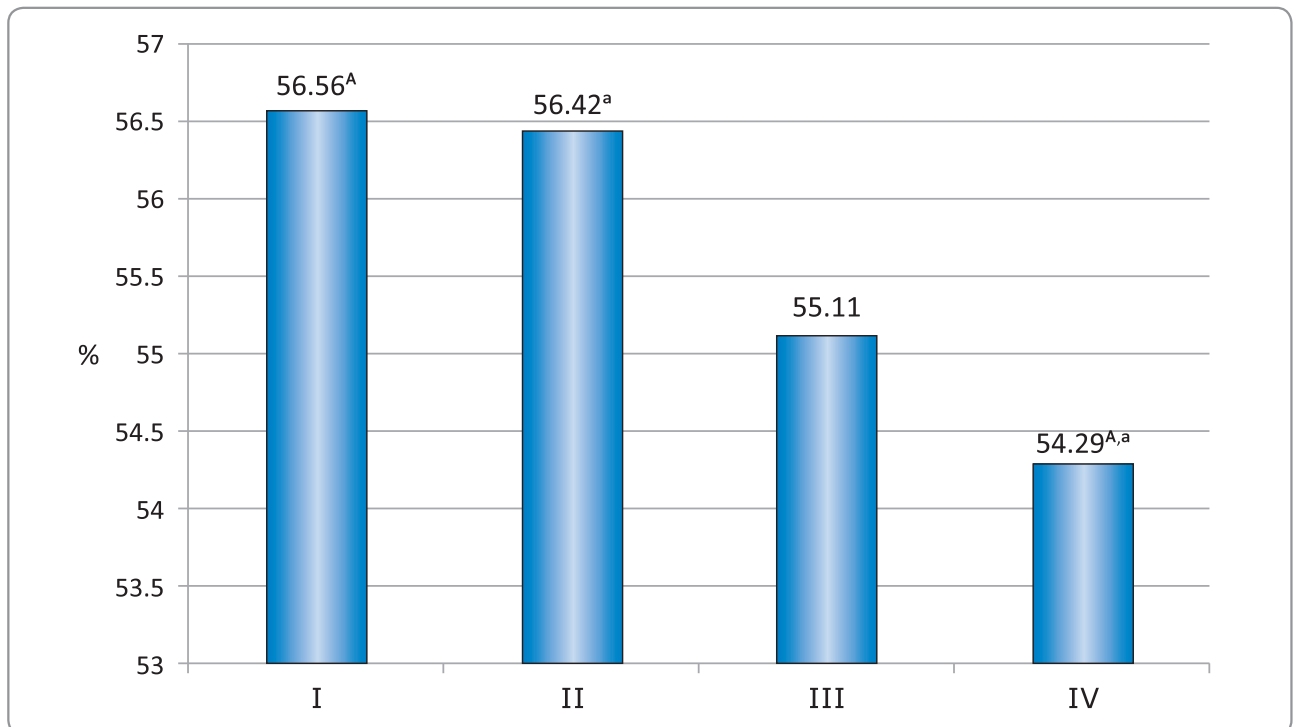


Figure 1. Dressing percentage calculated for the four cattle groups studied. Between groups, (^A; $p < 0.01$, ^a; $p < 0.05$)

They explained that age was probably of less importance, but the fact that the females had been gravid explained their lower dressing percentage. In present study, male and female Simmental beef cattle produced similar average dressing percentages (Figure 1).

Dressing percentages in well-fattened Short-horn animals ranged from 65% to 68%, Herefords achieved 65%, Sedans ranged from 65% to 70%, Charolais produced over 60% and Aberdeen Angus reached 65% (fattened bulls 75%) (Savic et al., 2007). Standard JUS EC1.022 is a local criterion for grading beef cattle, and includes dressing percentage (Anon., 1974). In young cattle aged 12 to 18 months, carcass yields (in this study termed dressing percentages) of both male and female cattle should be at least 56% for Class I, 54% for Class II and 50% for Class III cattle. Simmental beef cattle are Class III animals. Beef cattle older than 18 months (with a maximum of four permanent incisors with the exception of Class IA with two permanent incisors) should be classified as Class IA, so dressing percentage must be at least 58% (male and female). In our study, male Domestic Simmental cattle from our groups I and III would be classified as class IA if they had not more than two incisors. Groups V and VI beef cattle (female) would be classified as Class I animals, while animals from other groups of cattle would be classified as Class II (at least 54% yield) (Anon., 1974).

Drca (2009) reported that male Domestic Simmental type cattle from three different manufacturers in Serbia had dressing percentages between 54.20% and 55.40%, while females achieved between 53% and 55.40%. According to Petricevic et al. (2011), Domestic Simmental type bullocks of average weight of 500 kg had an average dressing percentage of 55.31% and beef cattle with an average weight of 600 kg had a dressing percentage of 56.30%. Kamiemiecki et al. (2009) found that Simmental x Charolais crossbreeds produced a dressing percentage of 58.5%.

Kamiemiecki et al. (2009) reported that the dressing percentage of male Charolais yearlings was 57.2% (average live weight of 523 kg at the age of 517 days), while male Charolais x Hereford crossbreeds had a dressing percentage of 56.9% (average live weight of 532 kg at age 547 days). Fiems et al. (2003) investigated conformation and dressing percentage (carcass yield, calculated on the weight of cold carcass) of double-musled Belgian blue cattle. The average carcass yield for males was 66.6% (prior to slaughter weight 755 kg, the average age of 648 days), and for females was 63.8% (prior to slaughter weight 740 kg, the average age of the 1,822 days). According to Stokovic et al. (2013), male Simmentals had carcass yields of 59.92% (prior to slaughter, weight was 555 kg at an average age of 420 days). Aleksic et al. (2002) showed that male Domestic Simmental x Limousine

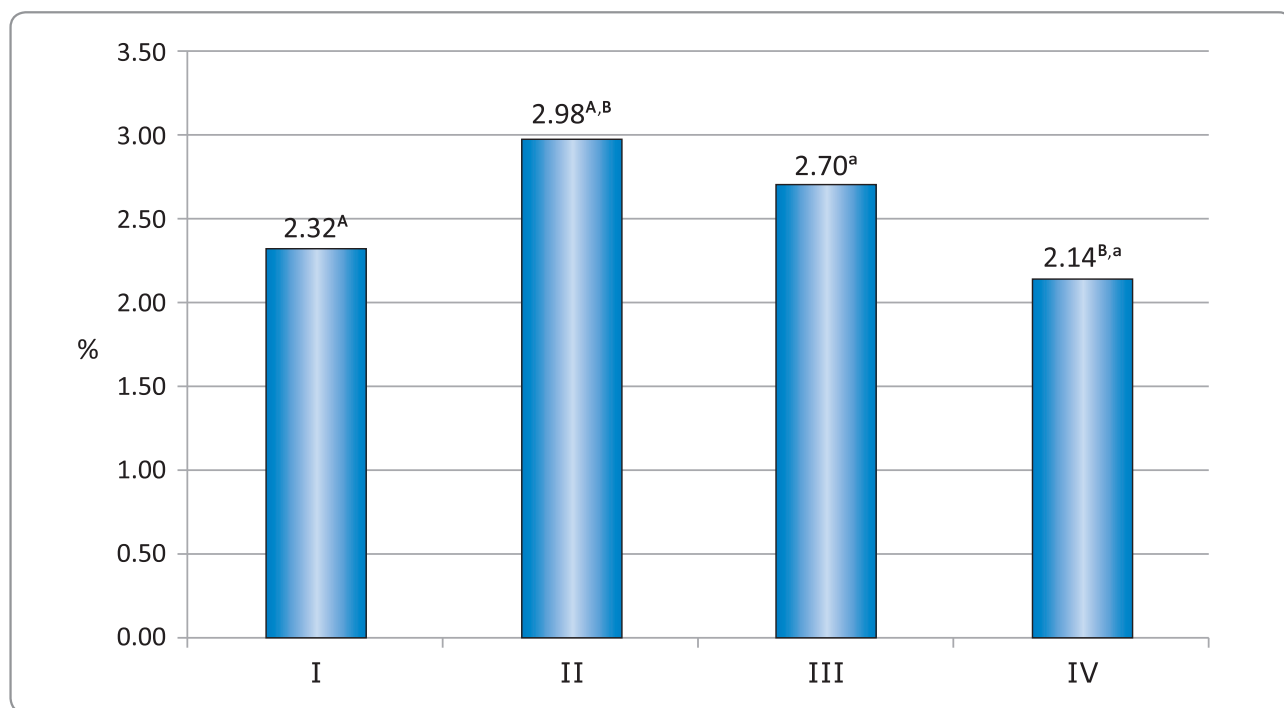


Figure 2. Chilling loss (%) (A, B; p<0.01; a ; p<0.05)

Table 3. Weight of forequarters and hindquarters ($X \pm SD$) of beef cattle groups

Weight (kg)	Group			
	I (n=50)	II (n=30)	III (n=10)	IV (n=10)
Forequarter	177.9 ^{A,B} ±30.39	161.5 ^{A,C} ±16.08	167.3 ^D ±12.49	133.0 ^{B,C,D} ±13.84
Hindquarter	147.8 ^{A,B} ±23.22	135.0 ^{A,C} ±15.53	137.7 ^D ±13.46	112.3 ^{B,C,D} ±14.78

Within a row and each parameter values were compared; Means with a common superscript letter differ: A, B, C, D; $p < 0.01$.

crossbreeds achieved a higher yield of 45.5% than male Domestic Simmentals. *Simoës et al.* (2005) showed that the yield was about 5% higher in animals weighing 650 kg (heavy breed) and 550 kg (lighter breed) prior to slaughter compared to animals with lower body mass (400 kg for the heavy breed and 300 kg for the lighter breed).

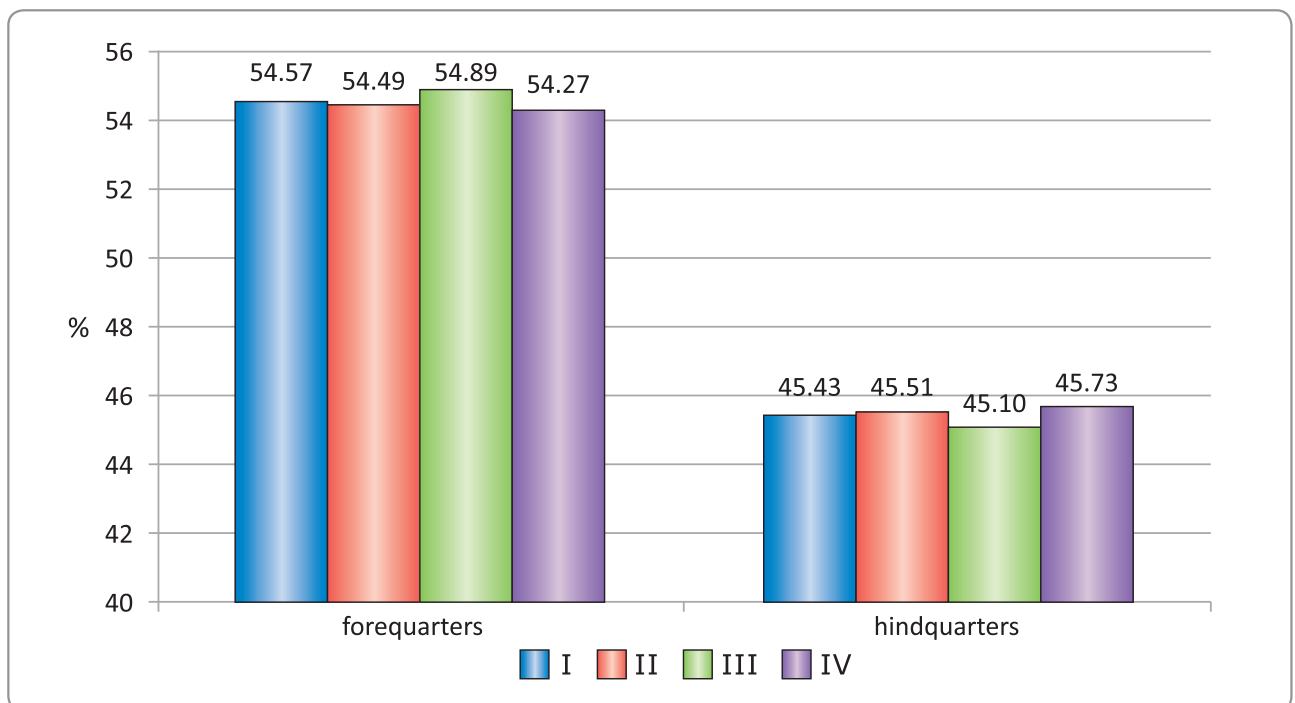
The average chilling loss of carcasses from the four groups of cattle is presented in Figure 2. Chilling loss was significantly higher in group II than in groups I and IV cattle ($p < 0.01$). Group III cattle had significantly higher chilling loss than group IV cattle. However, carcass cooling conditions were not the same in the four slaughterhouses. In spite of that, our results were similar to those obtained previously (*Petricević et al.*, 2011).

According to *Petricević et al.* (2011), the chilling loss of heifer carcasses was 2.52% when cattle weighed 500 kg before slaughter and the warm carcass mass was 277 kg, and 1.72% when cattle

weighed 600 kg before slaughter and the warm carcass mass was 334 kg. The chilling loss of male yearling carcasses, according to *Drca* (2009), was 2.33% to 2.94%, and for females, was between 3.01% and 3.36%. The author attributed this to males weighing more than females, as well as having better torso coverage with body fat. Chilling loss has great economic importance when the slaughter of a large number of animals is taken into consideration.

Average weights of forequarters and hindquarters of all cattle groups are shown in Table 3. Group I cattle had significantly higher forequarter and hindquarter weights than group II and IV cattle. Also, Simmental males (group I) had significantly higher forequarter and hindquarter weights than Simmental females (group II) ($p < 0.01$). The Holstein Friesian cattle had significantly lower forequarter and hindquarter weights than Simmental beef cattle ($p < 0.01$).

Figure 3 shows the participation of forequarters and hindquarters in the groups of Simmental

**Figure 3.** Participation of forequarters and hindquarters ($X \pm SD$) of cattle groups

and Holstein Friesian beef cattle. No significant differences were detected among the four groups, but participation of forequarters was higher in group III than in groups I, II and IV. The Holstein Friesian cattle had a higher participation of hindquarters than Simmental cattle.

In *Drca* (2009), participation of forequarters from male beef cattle was 47.48% and participation of hindquarters was 52.54%. Female beef cattle had a forequarter participation of 50.34% and hindquarter participation of 49.66%. There is generally a lack of data about mass and participation of forequarters and hindquarters. This may be due to the different methods of processing carcasses after cooling. The carcass cutting method is determined by the purpose

of the quarters (distribution) and practices in different countries (*Baltic*, 1994).

Conclusion

The highest average weight before slaughter, and mass of hot and cold carcasses was measured in male Simmental beef cattle, followed by female Simmentals, then young male bulls of the same breed. The lowest average pre-slaughter weight was seen in Holstein Friesian cattle. The dressing percentage (carcass yield) was higher in beef cattle with higher weights before slaughter. Chilling loss of the studied carcasses was variable.

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References

- Aleksic, S., Miscevic, B., Petrovic, M., Pavlovski, Z., Jospipovic, S. & Tomasevic, D. (2002). Ispitivanje faktora znacajnih za rezultate vrednosti randmana klanja muske toвне junadi domace simentalske rase i meleza domace simentalske rase sa limuzinom. *Biotechnology in Animal Husbandry*, 18 (3–4), 9–14.
- Anon. (2012). <http://www.slideshare.net/Roppa/global-meat-production-jan-2012>.
- Anon. (1974). JUS E.C1.022/1974 Meso od goveda u trupovima i polutkama za industrijsku preradu, Sl. list SFRJ br 55/1974.
- Baltic M. (1994). Kontrola namirnica. Institut za higijenu i tehnologiju mesa, Beograd.
- Baltic, Milan Z. & Boskovic M. (2015). When man met meat: meat in human nutrition from ancient times till today. *Procedia Food Science*, 5, 6–9.
- Chambaz, A., Scheeder, M. R. L., Kreuzer, M. & Dufey, P. A. (2003). Meat quality of Angus, Simmental, Charolais, Limousine steers compared at the same intramuscular fat content. *Meat Science*, 63, 491–500.
- Dokmanovic, M., Lukic, M., Baltic, M. Z., Ivanovic, J., Markovic, R., Grbic, S. & Glamoclija, N. (2014). Analysis of beef production volume in Serbia from 1985 to 2011. *Tehnologija mesa*, 55 (1), 73–80.
- Djordjevic M. (2016). Uperedna analiza mesnatosti trupova i odabranih parametara kvaliteta mesa junadi u tovu. Doktorska disertacija. Fakultet veterinarske medicine, Univerzitet u Beogradu.
- Drca, D. (2009). Examination of lean meat in beef cattle carcasses in slaughterhouse in Cajetina. University of Belgrade, Serbia.
- Fiems, L. O., De Campeneere, S., Van Caelenbergh, W., De Boever, J. L. & Vanacker, J. M. (2003). Carcass and meat quality in double-muscled Belgian Blue bulls and cow. *Meat Science*, 63, 345–352.
- Janjic S. (2004). Examination lean meat in beef cattle carcasses in slaughterhouse in Vracevsnica. University of Belgrade, Serbia.
- Kamieniecki, H., Wójcik, J., Pilarczyk, R., Lachowicz, K., Sobczak, M., Grzesiak, W. & Blaszczyk, P. (2009). Growth and carcass performance of bull calves born from Hereford, Simmental and Charolais cows sired by Charolais bulls. *Czech Journal of Animal Science*, 54 (2), 47–54.
- Maltin, C. A., Sinclair, K. D., Warriss, P. D., Grant, C. M., Porter, A. D., Delday, M. I. & Warkup, C. C. (1998). The effects of age at slaughter, genotype and finishing system on the biochemical properties, muscle fibre type characteristics and eating quality of bull beef from suckled calves. *Animal Science*, 66, 341–348.
- Mandell, I. B., Gullett, E. A., Wilton, J. W., Allen, O. B. & Kemp, R. A. (1998). Effects of breed and dietary energy content within breed on growth performance, carcass and chemical composition and beef quality in Hereford and Simmental steers. *Canadian Journal Animal Science*, 78, 533–541.
- May, S. G., Dolezal, H. G., Gill, D. R., Ray, F. K., & Buchanan, D. S. (1992). Effects of days fed, carcass grade traits, and subcutaneous fat removal on postmortem muscle characteristics and beef palatability. *Journal of Animal Science*, 70, 444–453.
- Moloney, A. P., Mooney, M. T., Kerry, J. P. & Tory, D. J. (2001). Producing tender and flavoursome beef with enhanced nutritional characteristics. *Proceedings of the Nutrition Society*, 60, 221–229.
- Neumann, W. (2002). Current issues in beef meat production with special reference to methods of fattening calves with cows. *Biuletyn Informacyjny Instytutu Zootechniki*, 40, 17–32.

- Nuernberg, K., Dannenberger, D., Nuernberg, G., Ender, K., Voigt, J., Scollan, N. D., Wood, J. D., Nute, G. R. & Richardson, R. I. (2005).** Effect of a grass-based and a concentrate feeding system on meat quality characteristics and fatty acid composition of *longissimus* muscle in different cattle breeds. *Livestock Production Science*, 94, 137–147.
- Petriceovic, M., Stanicic, N., Sretenovic, M., Petrovic Lj., Stajic, S. & Niksic, D. (2011).** Properties and composition of carcass of domestic spotted young cattle of two pre-slaughter weights. *Biotechnology in Animal Husbandry*, 24 (4), 1443–1450.
- Petriceovic, M., Aleksic, S., Petrovic, M. M., Pantelic, V., Ostojic-Andric, D., Stanicic, N. & Niksic, D. (2015).** Comparative study of fattening and slaughter traits of male Simmental breed and crosses with Charolais breed. *Biotechnology in Animal Husbandry* 31, 265–272.
- Piasentier, E., Bovolenta S., Moiola, L. Orru, R. Valusso, Corazzin M., Iasentier, E., Bovolenta S., Moiola B., Orru L., Valusso R. & Corazzin, M. (2009).** Fatty acid composition and sensory properties of Italian Simmental beef as affected by: Fatty acid composition and sensory properties of Italian Simmental beef as affected by gene frequency of Montbeliarde origin. *Meat Science*, 83, 543–550.
- Sami A. S., Augustini C. & Schwarz, F. J. (2004).** Effect of feeding intensity and time on feed on performance, carcass characteristics and meat quality of Simmental bulls. *Meat Science*, 67, 195–201.
- Sanudoa, C., Maciea, E. S., Olletaa, J. L., Villarroel, M., Paneaa, B. & Albert, P. (2004).** The effects of slaughter weight, breed type and ageing time on beef meat quality using two different texture devices. *Meat Science*, 66, 925–932.
- Savic, M., Jovanovic, S. & Vegara, M. (2007).** Stocarstvo - farmske i socijalne zivotinje, Fakultet veterinarske medicine, Beograd.
- Simoos, J. A., Mira, J. F. F., Lemos, J. P. C. & Mendes, I. A. (2005).** Dressing percentage and its relationship with some components of the fifth quarter in Portuguese cattle breeds. *Livestock Production Science*, 96, 157–63.
- Sinclair, K. D., Cuthbertson, A., Rutter, A. & Franklin, M. F. (1998).** The effects of age at slaughter, genotype and finishing system on the organoleptic properties and texture of bull beef from suckled calves. *Animal Science*, 66, 329–340.
- Stokovic, I., Starcevic, K., Karadjole, I., Krizanovic, P., Bozic, P. & Mauric, M. (2013).** The chemical composition and fatty acid profile of the *longissimus dorsi* muscle in young Simmental bulls. *Veterinarski arhiv* 83, 135–144.
- Waritthitham, A., Lambertz, C., Langholz, H. J., Wicke, M. & Gaulty, M. (2010).** Assessment of beef production from Brahman x Thai native and Charolais x Thai native cross-bred bulls slaughtered at different weights. I: Growth performance and carcass quality. *Meat Science*, 85, 191–195.
- Williams, P. (2007).** Nutritional composition of red meat, *Nutrition & Dietetics*, 64, 113–119.
- Zapletal, D., Chládek, G., & Subrt J. (2009).** Breed variation in the chemical and fatty acid. Breed variation in the chemical and fatty acid compositions of the *longissimus dorsi* muscle in Czech Fleckvieh and Montbeliarde cattle. *Livestock Science*, 123, 28–33.

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